National Aeronautics and Space Administration

Human Exploration and Operations Committee Status

Ken Bowersox
Committee Chair
July 31st, 2014

NAC HEO Committee Members

- Ms. Bartell, Shannon
- Mr. Bowersox, Ken, ***Chair***
- Ms. Budden, Nancy Ann
- Dr. Chiao, Leroy
- Dr Condon, Stephen "Pat"
- Mr. Cuzzupoli, Joseph W.
- Mr. Holloway, Tom
- Mr. Lon Levin
- Dr. Longenecker, David E.
- Mr. Lopez-Alegria, Michael
- Mr. Malow, Richard N.
- Mr. Odom, Jim (James)
- Mr. Sieck, Robert
- Mr. Voss, James

Human Exploration & Operations Mission Directorate

Organizational Structure

Public Affairs/Legislative Affairs
Communications
Int'l/Interagency Relations
General Counsel

Associate Administrator
Deputy Associate Administrator
Deputy AA for Policy & Plans

Chief Technologist
Chief Scientist
Chief Engineer
Safety & Mission Assurance
Chief Health & Medical Officer

Strategic Analysis & Integration

Mission Support Services

Resources Management

Space Comm & Navigation

Launch Services

Space Shuttle

Exploration Systems Development
- Orion
- SLS
- GSDO

Human Spaceflight Capabilities
- Core Capabilities (MAF, MOD, SFCO, EVA)
- RPT

International Space Station
- System O&M
- Crew & Cargo Transportation Services

Commercial Spaceflight Development
- Comm. Crew
- COTS

Advanced Exploration Systems
- AES
- Robotic precursor measurements

Space Life & Phys. Sciences Research & Applications
- HRP, CHS
- Fund. Space Bio
- Physical Science

ISS Nat'l Lab Mgt

NAC HEO Meetings

<u>NAC HEO Committee Meeting</u>

Monday, June 23, 2014

Human Exploration Plans, Evolvable Mars Campaign Study

Monday July 28, 2014

Joint Meeting with the Science Committee

- Human Exploration and Operations Joint Efforts with the Science Mission Directorate
- SLS Capabilities

Program Status – Exploration Systems, Commercial Crew, ISS

Tuesday July 29, 2014

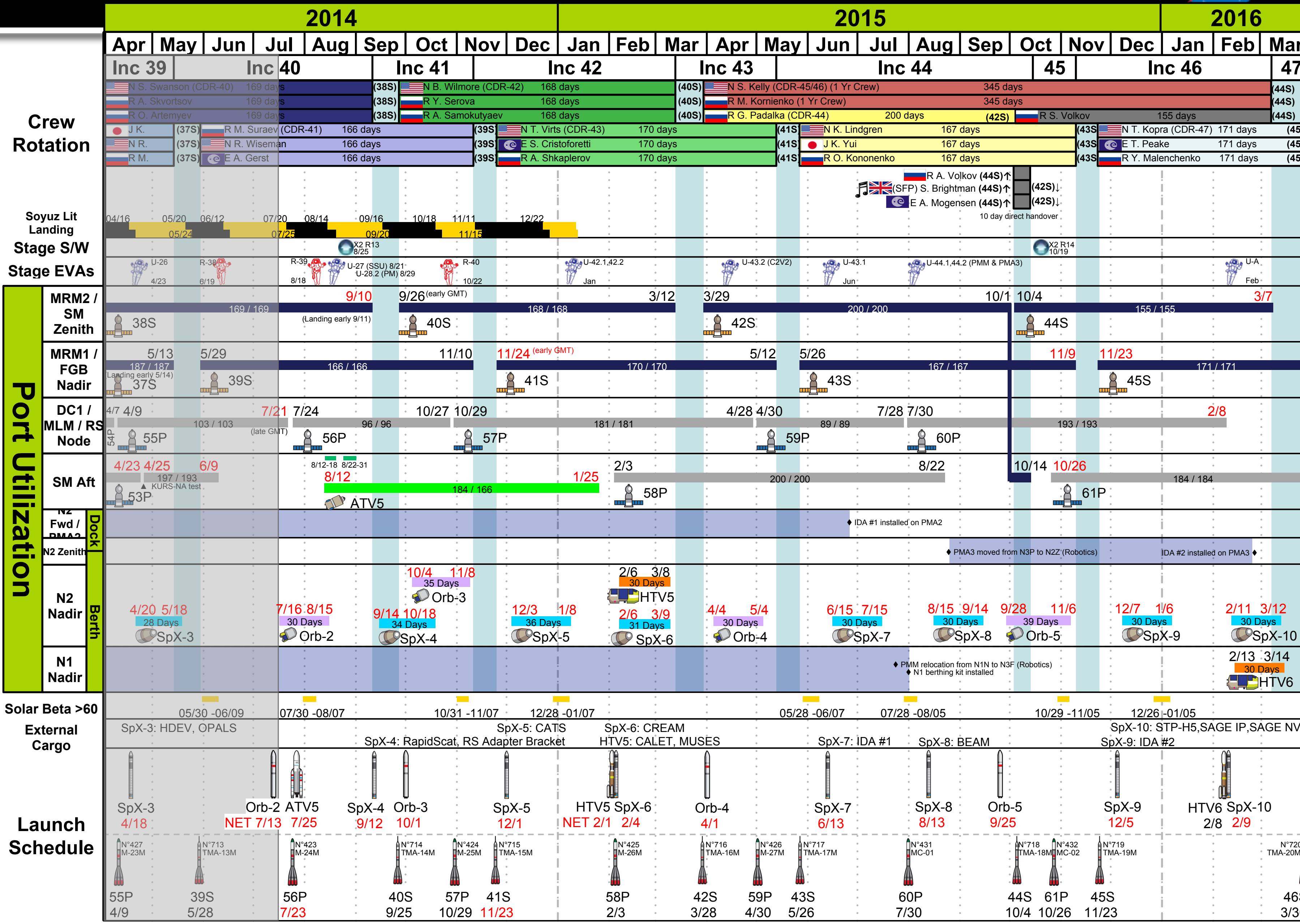
Committee Discussion and Deliberation

Status of the ISS USOS
NASA Advisory Council HEOMD Committee

Daniel W. Hartman
Deputy Manager, ISS Program

July 2014

NASA: OC4/John Coggeshall
MAPI: OP/Randy Morgan
Chart Updated: July 2014
SSCN/CR: 14071 + 14145 + 1421



Vehicle: 39 Soyuz

Launch: May 28, 2014; (with 4 orbit rendezvous)

Docking: May 29, 2014;

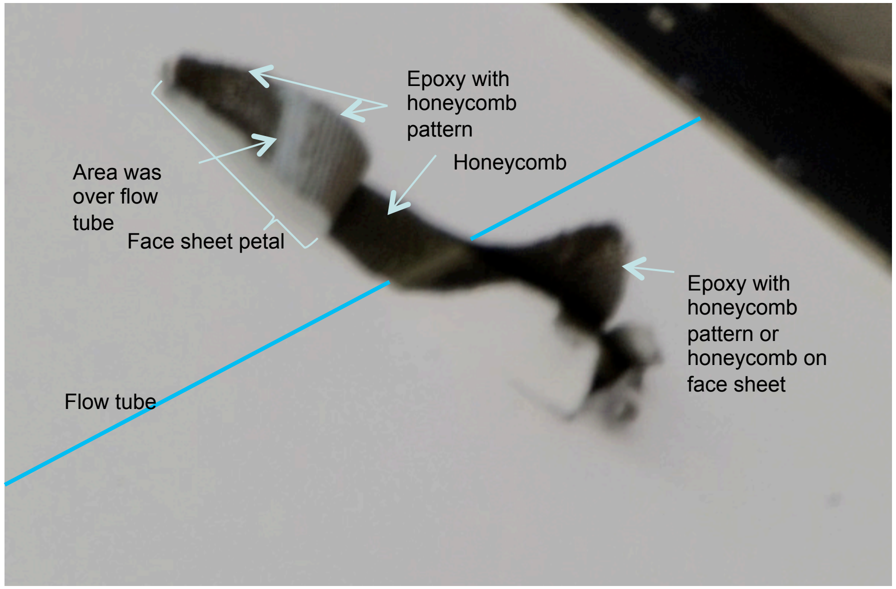
Undock/Landing: November 10, 2014

<u>38 Soyuz crew</u>
Alexander Skvortsov, Soyuz Commander
Oleg Artemiev, Flight Engineer
Steve Swanson, Flight Engineer

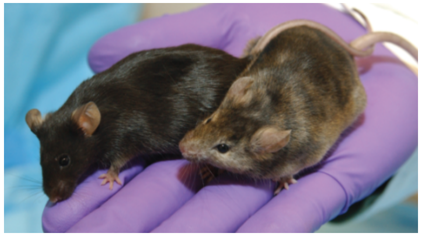
<u>39 Soyuz Crew</u>
Maxim Suraev, Soyuz Commander
Reid Wiseman, Flight Engineer
Alexander Gerst (ESA), Flight Engineer

Pertinent ISS Vehicle Issues (cont.)

Issue	Impact to Stage Ops	Rationale
P4 PVR MMOD Strike	No	Imagery review revealed a MMOD impact occurred between 5/12 and 6/20 on panel 3 of the P4 PVR. • S&M initial assessment shows no apparent structural damage • Unclear if damage would impact ability to retract PVR radiator, but currently no plans to do so • P4 ammonia mass trending shows no flow tube rupture (Small leaks will need to be trended long term)

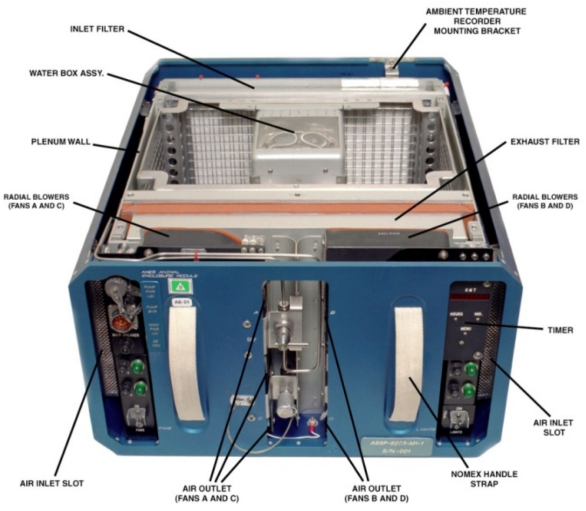


Rodent Research-1: "The lack of an animal facility for rodents on the ISS suitable for long-duration studies on adult animals is a major research impediment that will hamper the ability to obtain information important for maintaining astronaut health and fitness for duty." *-NRC Decadal Survey, 2011.*



- 10 NASA mice: Evaluation of hardware and on-orbit operations
- 10 CASIS mice: Pharmaceutical company evaluating muscle atrophy

- Based on existing AEM design
  - Flown 27 times on Shuttle
  - Modified to meet ISS needs (reduced acoustics, added cameras, improved airflow
- Single MLE unit houses 10 mice or 3 – 6 rats (20 mice on SpaceX-4)
- Temperature and RH monitoring, no active thermal control
- Transfer animals to a clean Rodent Habitat with a full complement of food and water after 20 - 30 days to achieve longer duration missions
- Improved science and animal husbandry through video monitoring and in-flight access
- Animals housed in two groups of five on either side of the Habitat
- Animals loaded in the Transporter at L-25 hrs
  - Support up to 2 launch attempts before change out with a new Transporter



AEM OVERVIEW AND AIR FLOW SYSTEM

ISS Top Program Risk Matrix
Post April 16, 2014 PRAB

Corrective/Preventative Actions

None

Watch Items

No Watch Items Elevated

Continual Improvement

None

LIKELIHOOD	1	2	3	4	5
5				2	1
4			3	2	
3		1	3		4
2		1			
1					

CONSEQUENCE

Low	Medium	High

C – Cost	S – Schedule	T – Technical	Sa – Safety

▲ – Top Program Risk (TPR)

Added: 6484

Removed: 2810 - RS MM/OD Shielding and 5688 - ISS Solar Array MGNT

Rescored: 6169

Risks (L x C)

Score: 5 x 5
- ▲ 6352 - Lack of Assured Access to ISS - (OH) - (C,S,T,Sa)

Score: 5 x 4
- ▲ 6370 - ISS Pension Harmonization - (OH) - (C)
- ▲ 6344 - ISS Operations Budget Reduction - (OH) - (C)

Score: 4 x 4
- ▲ 6372 - Full ISS Utilization at 3 Crew - Level 1 - (OZ) - (C,S)
- ▲ 6439 - EPROM Memory Leakage - (OD) - (C,S,T,Sa)

Score: 3 x 5
- ▲ 6484 - ORDEM 3.0 Orbital Debris Model- CA, OB, OC, OD, OE, OK, OM, ON, OX - (S,T,Sa)
- ▲ 6444 - ISS Cascading Power Failure - (OM) - (C,S,T,Sa)
- ▲ 6450 - Potential Inability to Support ISS Critical Contingency (& other) EVA Tasks - (XA) - (C,S,T,Sa)
- ▲ 6382 - Structural Integrity of Solar Array Wing (SAW) Masts due to MMOD Strikes - (OB) - (S,T,Sa)

Score: 4 x 3
- ▲ 5269 - The Big 13 Contingency EVA's - (OB) - (S,T,Sa)
- ▲ 6169 - Visual Impairment / Intracranial Pressure - (SA) - (C,S,T,Sa)
- ▲ 6438 - C2V2 Comm Unit Vendor Misinterpreting ISS Requirements - (OG) - (C,S,T)

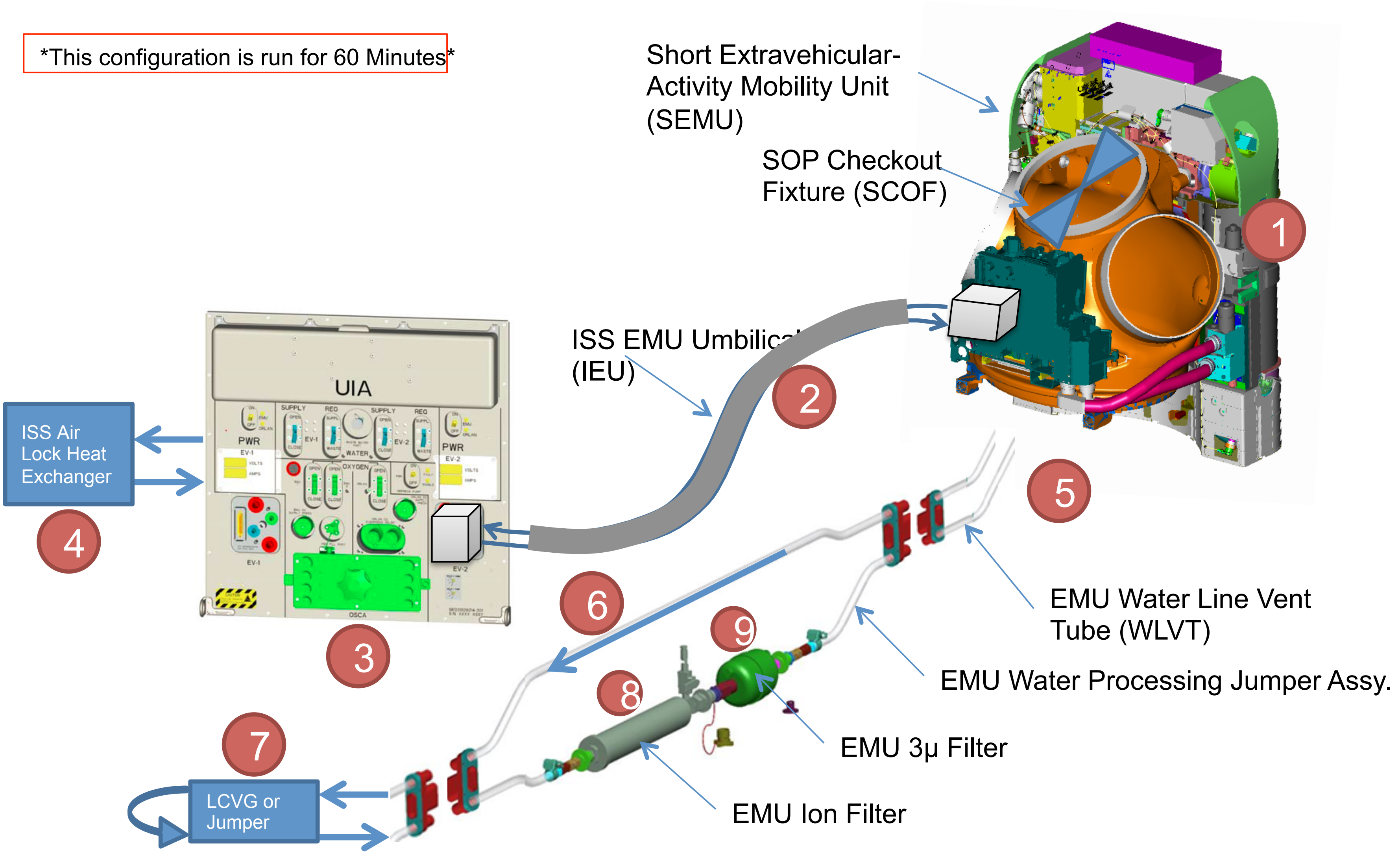
Score: 3 x 3
- ▲ 6452 - Lack of Sufficient Sparing for the Ku-Band Space to Ground Transmitter Receiver Controller (SGTRC) to reach 2020 - (OD) - (C,S,T)
- ▲ 6420 - NDS Qualification Schedule - (OG) - (C,S,T)
- ▲ 6408 - FGB Sustaining Contract and FGB spares plan post 2016 undefined - (OB) - (C,S,T,Sa)

Score: 3 x 2
- ▲ 6039 - Carbon Dioxide Removal Assembly (CDRA) Function - (OB) - (C,T,Sa)

Score: 2 x 2
- ▲ 5184 - USOS Cargo Resupply Services (CRS) Upmass Shortfall - 2010 through 2016 - (ON) - (S,T)

ALCLR Ion Bed Use

This configuration is run for 60 Minutes



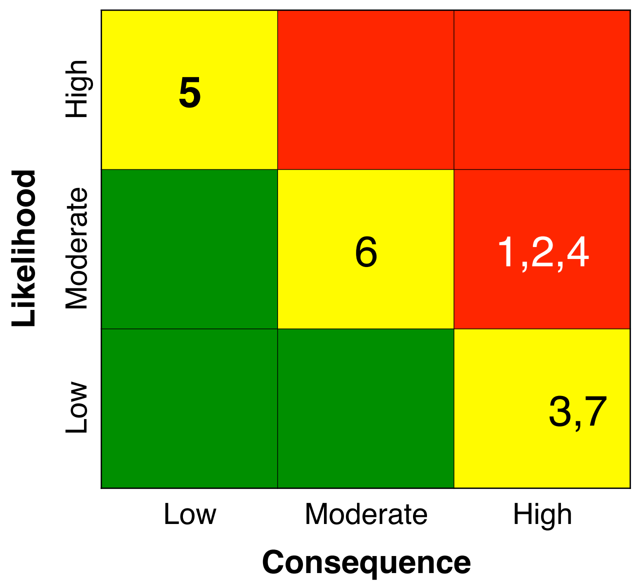
Commercial Spaceflight Development Update

July 2014
NAC HEO Committee Meeting
Philip McAlister

Current Status

- COTS Cargo has been successfully completed and regular resupply missions to the ISS are in progress.
- Commercial Crew Program is concluding it's final Space Act Agreement phase (CCiCap).
- The contract(s) for the final phase of Commercial Crew development (CCtCap) are planned to be awarded in August/September of this year.
- Next month, NASA will award multiple no-exchange-of-funds Space Act Agreements for the Collaborations for Commercial Space Capabilities initiative.

CCP Level I Risk Matrix



1. NASA costs may exceed NASA budget →
2. NASA-unique requirements may drive cost →
4. Lack of competition →

5. Technical/budget challenges may delay services →

6. CCtCap contract mechanism may lead to safety/ cost risk →

3. NASA culture change may not be successful →
7. Partner(s) may not complete certification →

Trend

- ↓ Decreasing (Improving)
- ↑ Increasing (Worsening)
- → Unchanged
- N New

Collaborations for Commercial Space Capabilities

Advancing private-sector integrated space capabilities

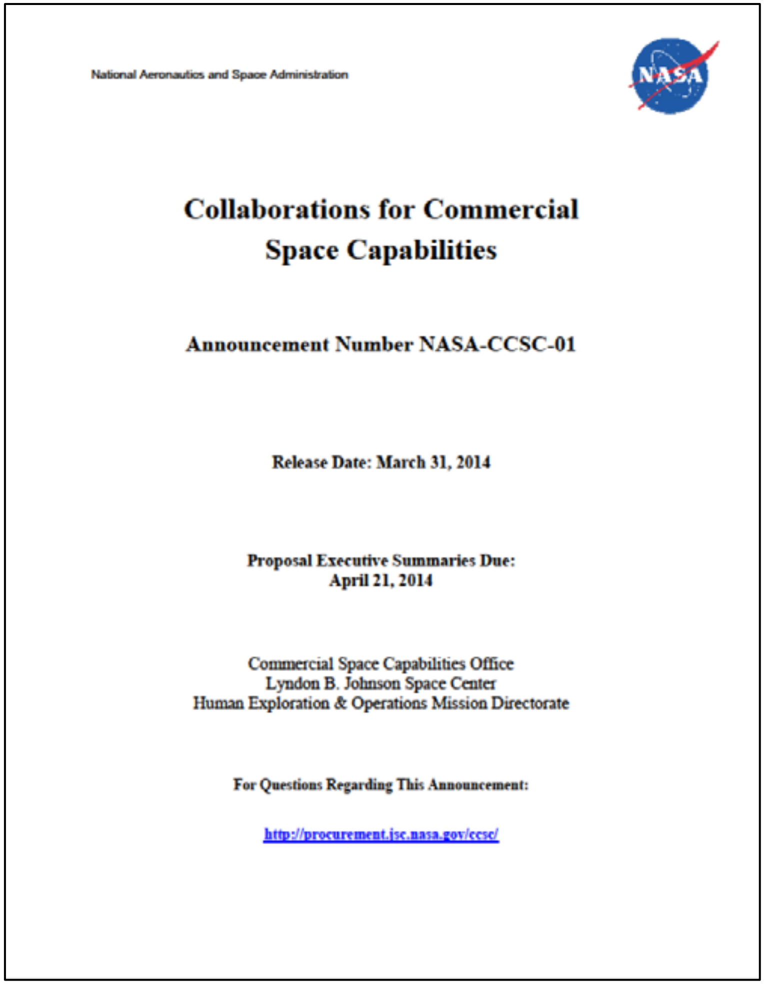
Emerging products or services have potential for commercial availability to government and non-government customers.

Spurring economic growth as new space markets are created

New capabilities may result in opportunities for industry to provide cost-effective commercial products and services to NASA.

Current Status

- Evaluating proposals
- Selection in August
- Execution beginning September


National Aeronautics and Space Administration

Collaborations for Commercial Space Capabilities

Announcement Number NASA-CCSC-01

Release Date: March 31, 2014

Proposal Executive Summaries Due:
April 21, 2014

Commercial Space Capabilities Office
Lyndon B. Johnson Space Center
Human Exploration & Operations Mission Directorate

For Questions Regarding This Announcement:

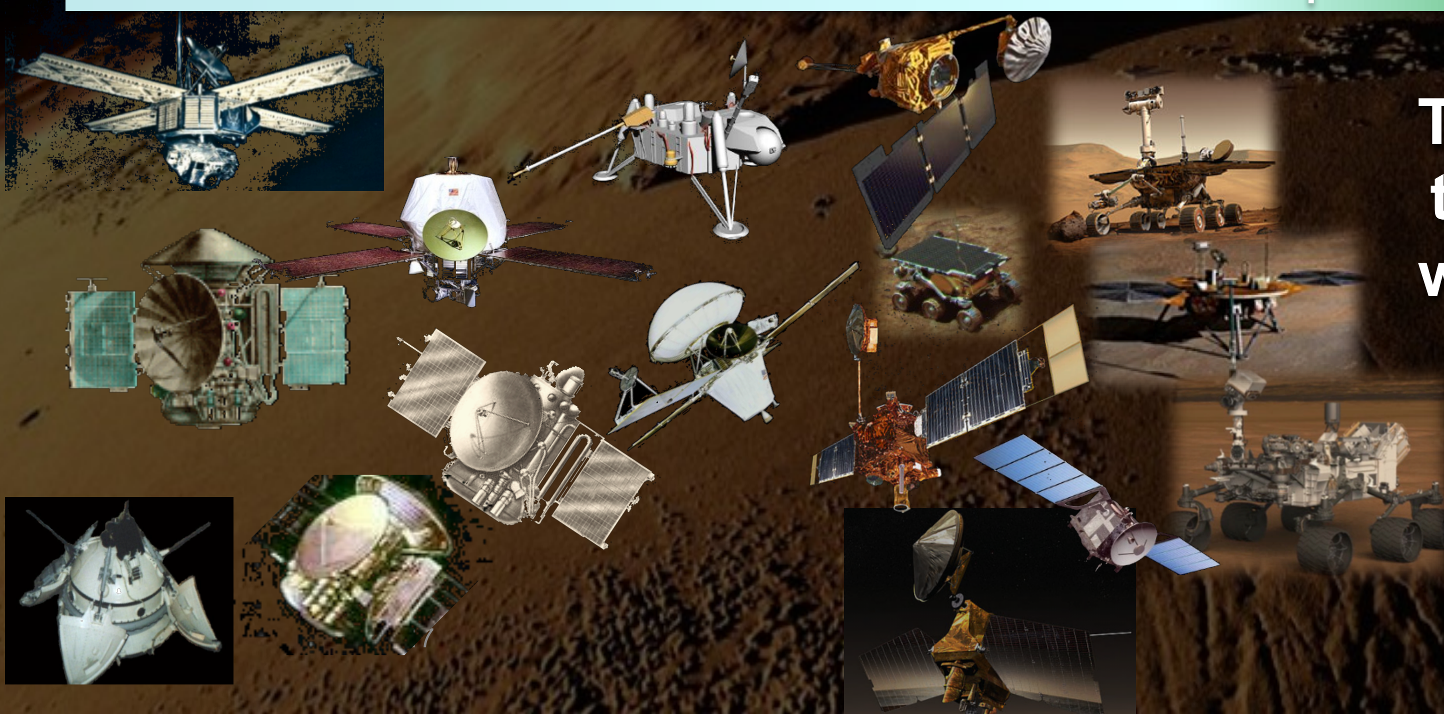
http://procurement.jsc.nasa.gov/ccsc/

HEO and SMD Joint Activities

James L. Green
Director, Planetary Science
July 28, 2014

For Human Exploration - What’s Left to Know?

In the past 50 years, robotic missions have contributed data that reduces the risks of future human Mars exploration



There’s more to know, but we’re well on our way

Radiation Measurements on Mars

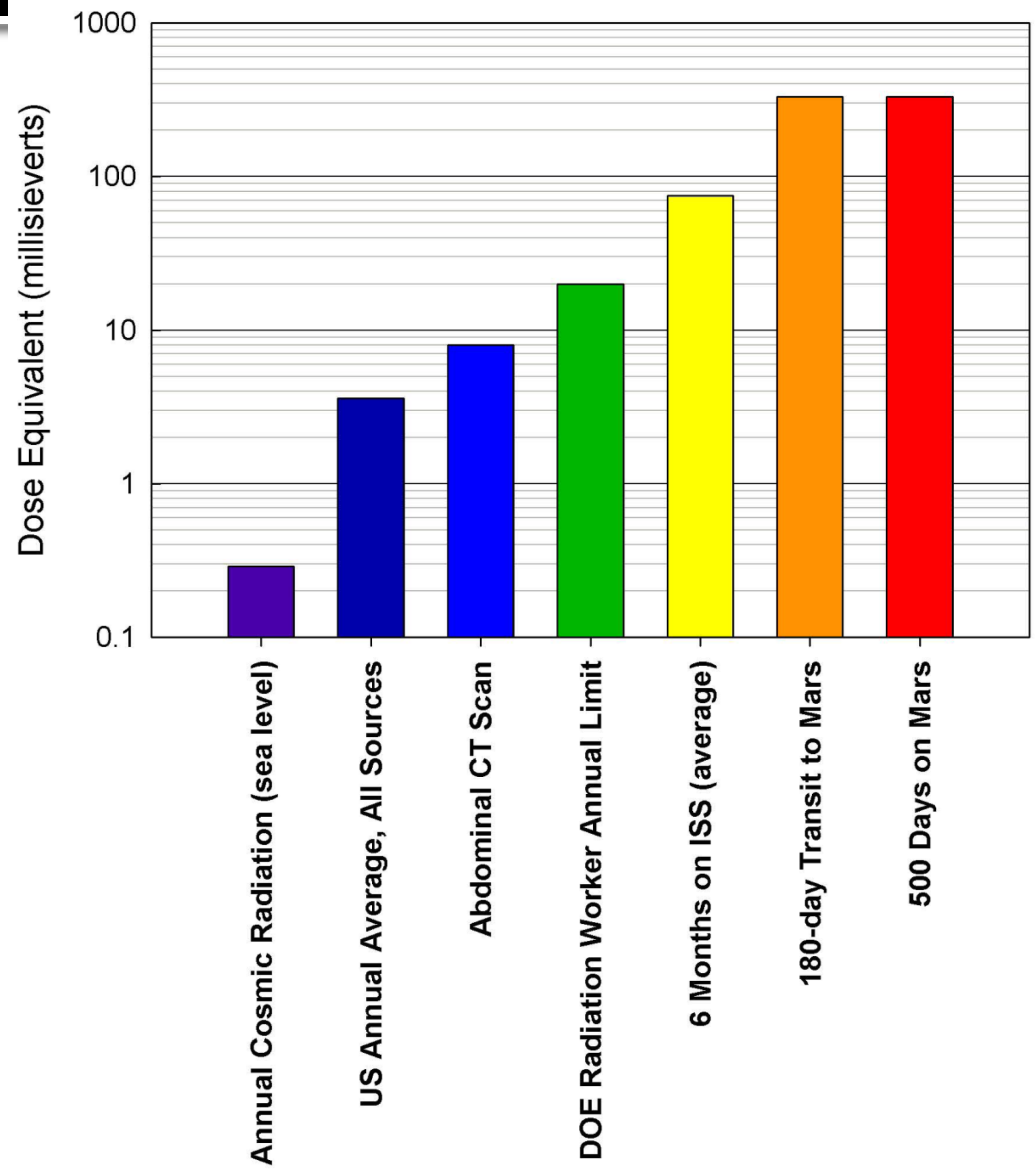
RAD measurements show:

A return trip to Mars results in an exposure of
Cruise: 662 +/- 108 mSv
On Mars: 320 +/- 50 mSv

In total ~ 1000 mSv

Compare to:

6 mos. on ISS: 75-90 mSv
Radiation worker: 20 mSv/y
Abdominal CT scan: 8 mSv

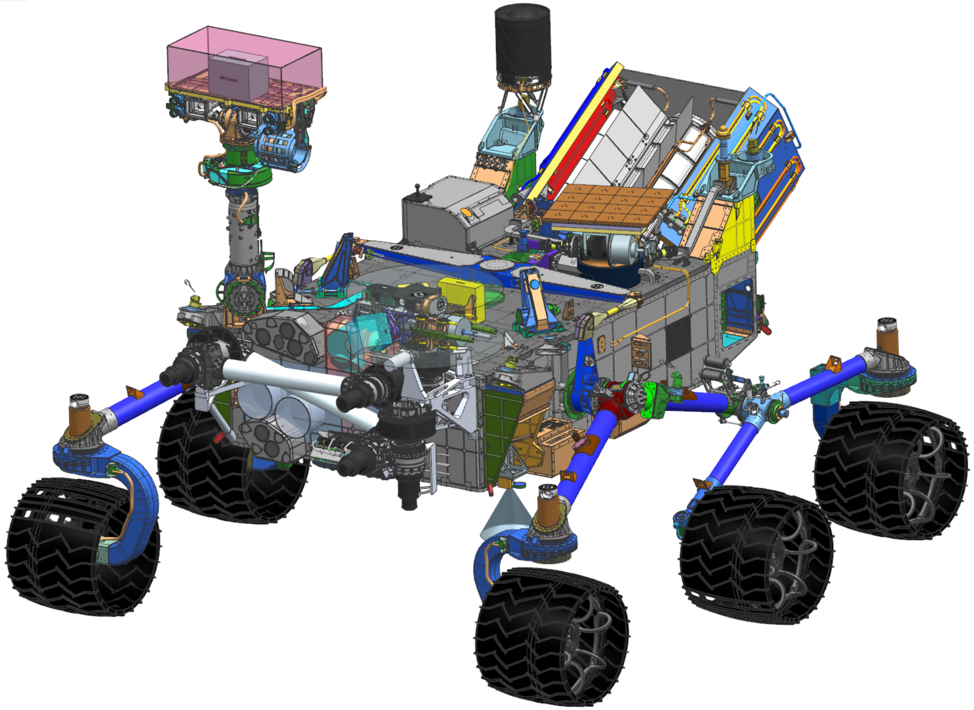


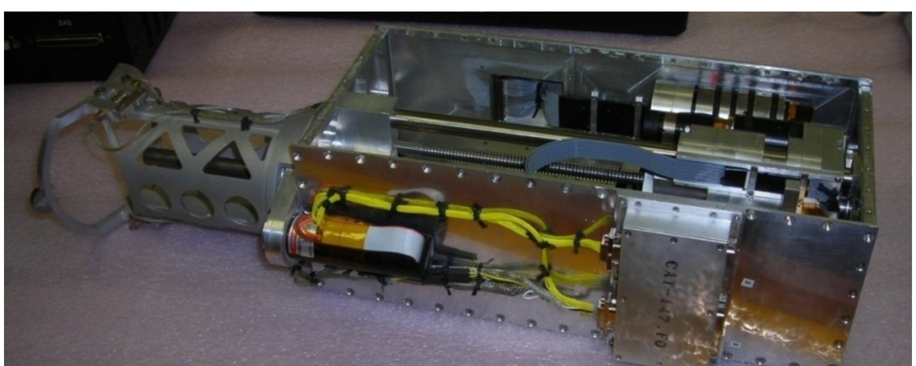
Seeking signs of life: Mars 2020 Rover

Conduct rigorous *in situ* science

Geologically diverse site of ancient habitability

Coordinated, nested context and fine-scale measurements



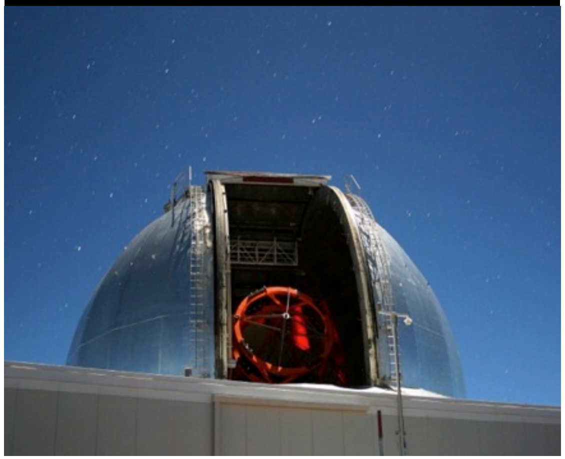
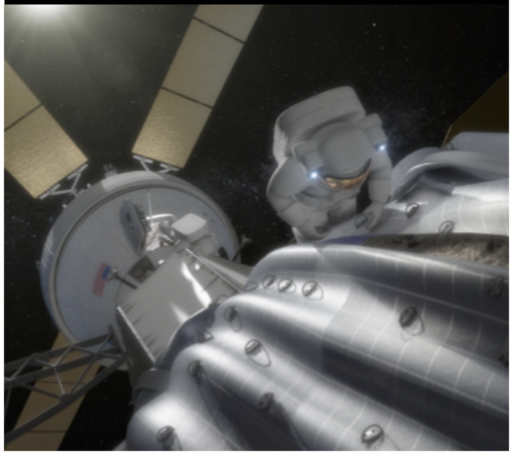


Enable the future

Critical ISRU and technology demonstrations required for future Mars exploration

Returnable cache of samples

Asteroid Redirect Mission: 3 Segments

Identify	Redirect	Explore
		
Asteroid Identification: Ground and space based near Earth asteroid (NEA) target detection, characterization and selection	**Asteroid Redirect Robotic Mission:** High power solar electric propulsion (SEP) based robotic asteroid redirect to lunar distant retrograde orbit	**Asteroid Redirect Crewed Mission:** Orion and Space Launch System based crewed rendezvous and sampling mission to the relocated asteroid

National Aeronautics and Space Administration

NASA's Space Launch System: A Revolutionary Capability for Science

Bill Hill

Deputy Associate Administrator

Exploration Systems Development Division

NASA Headquarters

Stephen Creech

Deputy Manager

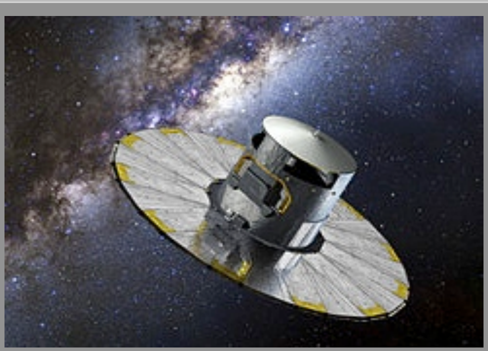
SLS Spacecraft/Payload Integration and Evolution

July 2014

www.nasa.gov/sls

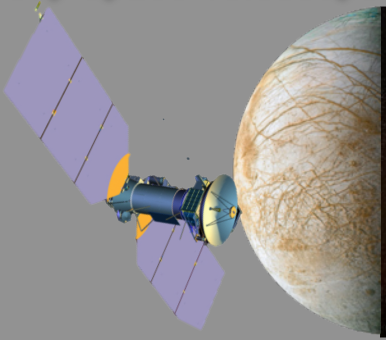
SLS Benefits to Space Science

- **Greatest mass lift capability** of any launch vehicle in the world.
- **Largest payload fairings** of any launch vehicle produce greatest available volume.
- **High departure energy** availability for missions through the solar system and beyond.

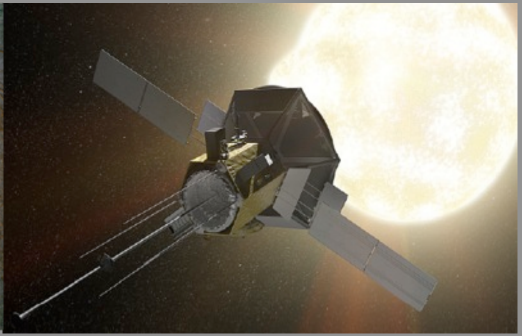


Deep Space Telescope

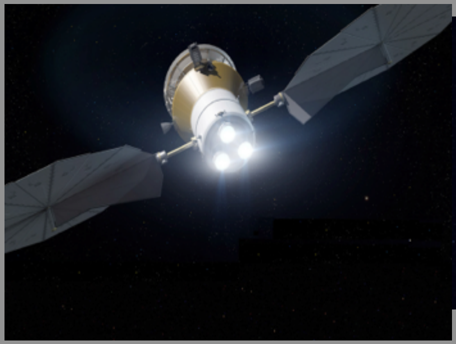
Mars Sample Return



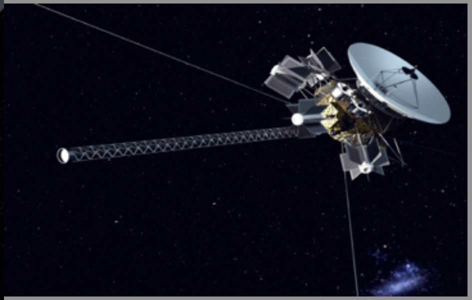
Europa Clipper



Solar Probe



Uranus Spacecraft



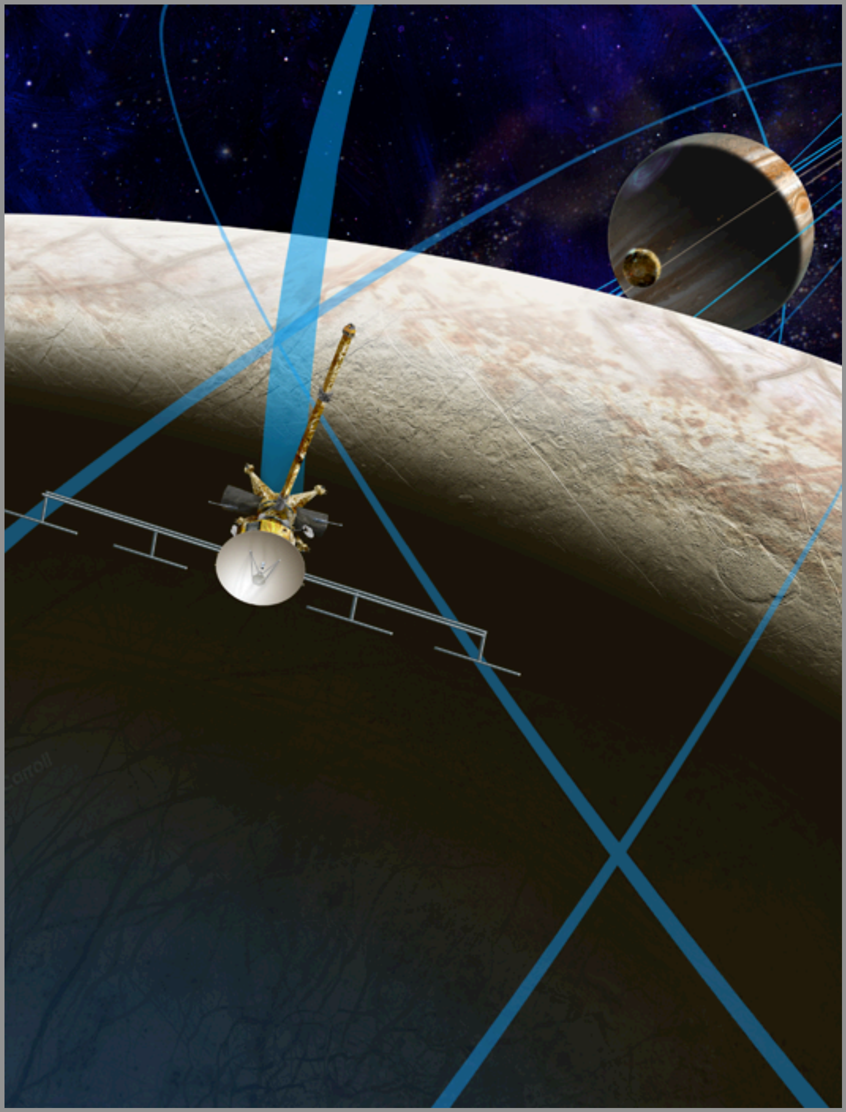
Interstellar

Case Study: Europa Clipper

- **Europa exploration** was identified as a high priority in the "Visions and Voyages" planetary science decadal survey.

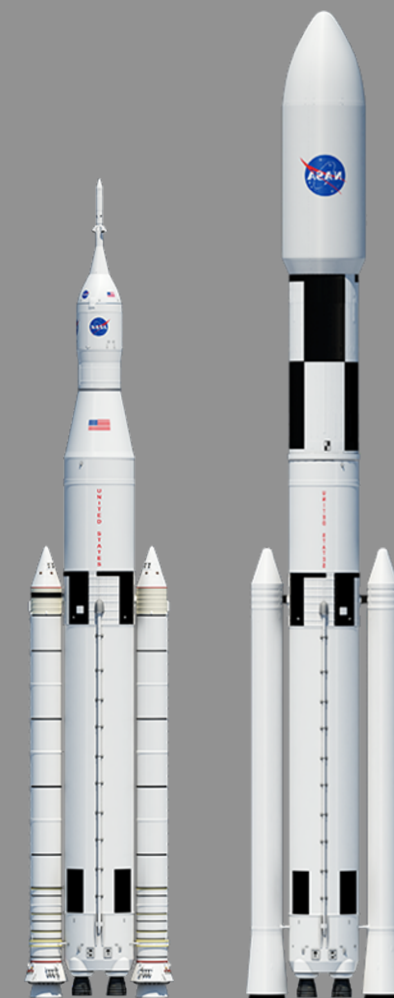
- **SLS can provide direct injection to Jupiter,** eliminating several years of planetary gravity assists to reduce flight time to Europa from 6.3 years to 2.7.

- **Additional benefits of SLS** for Europa Clipper include reduced operational costs, reduced mission risk, and greater mass margin.



Summary

- **SLS provides capability for human exploration missions.**
  - 70 t configuration enables EM-1 and EM-2 flight tests.
  - Evolved configurations enable missions including humans to Mars.
- SLS offers unrivaled benefits for a variety of missions.
  - 70 t provides greater mass lift than any contemporary launch vehicle; 130 t offers greater lift than any launch vehicle, ever.
  - With 8.4m and 10m fairings, SLS will over greater volume lift capability than any other vehicle.
  - Initial ICPS configuration and future evolution will offer highest-ever C3.
- SLS is currently on schedule for first launch in December 2017.
  - Preliminary design completed in July 2013; SLS is now in implementation.
  - Manufacture and testing are currently underway.
  - Hardware now exists representing all SLS elements

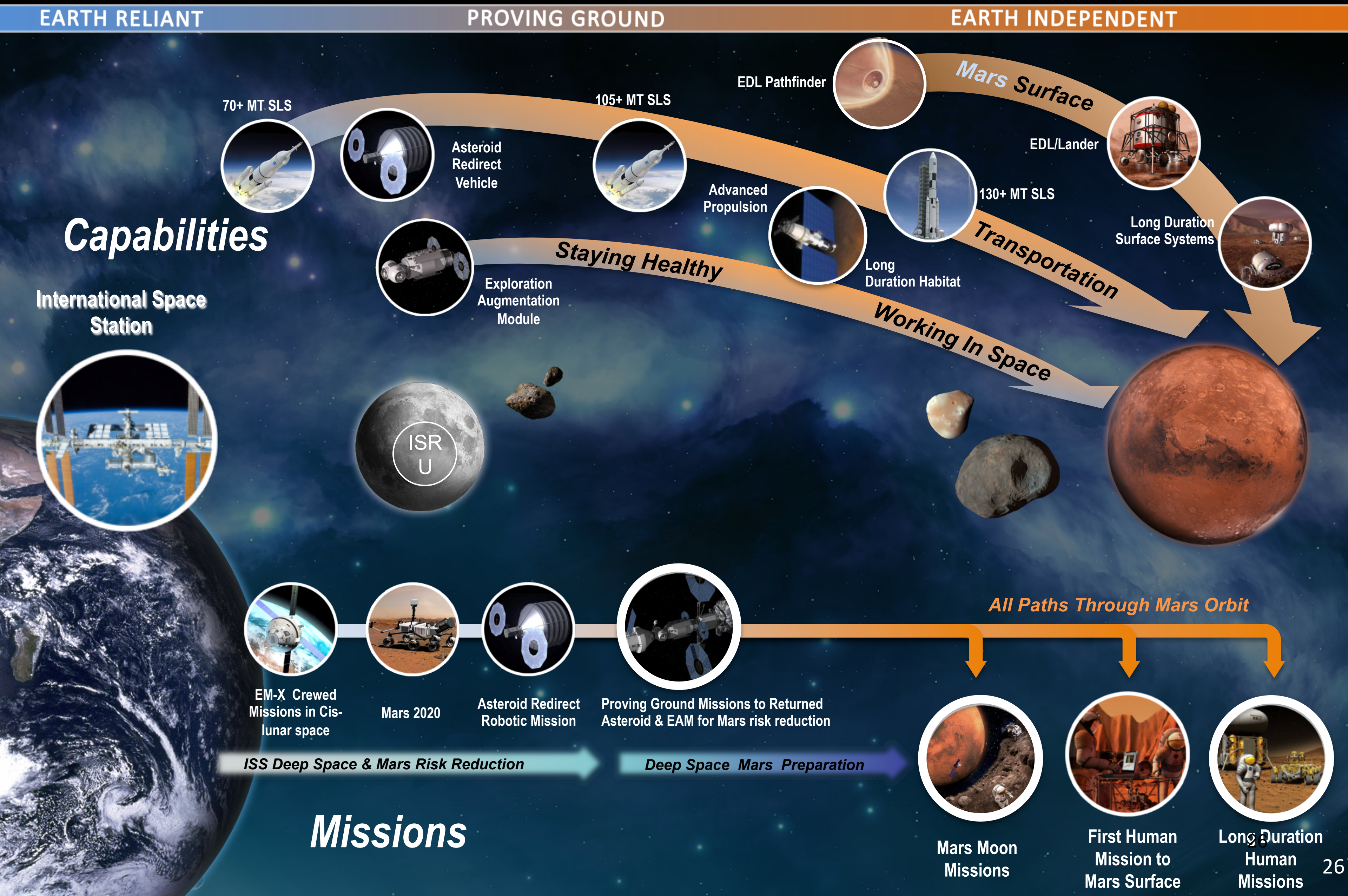


NASA Advisory Council HEO Committee

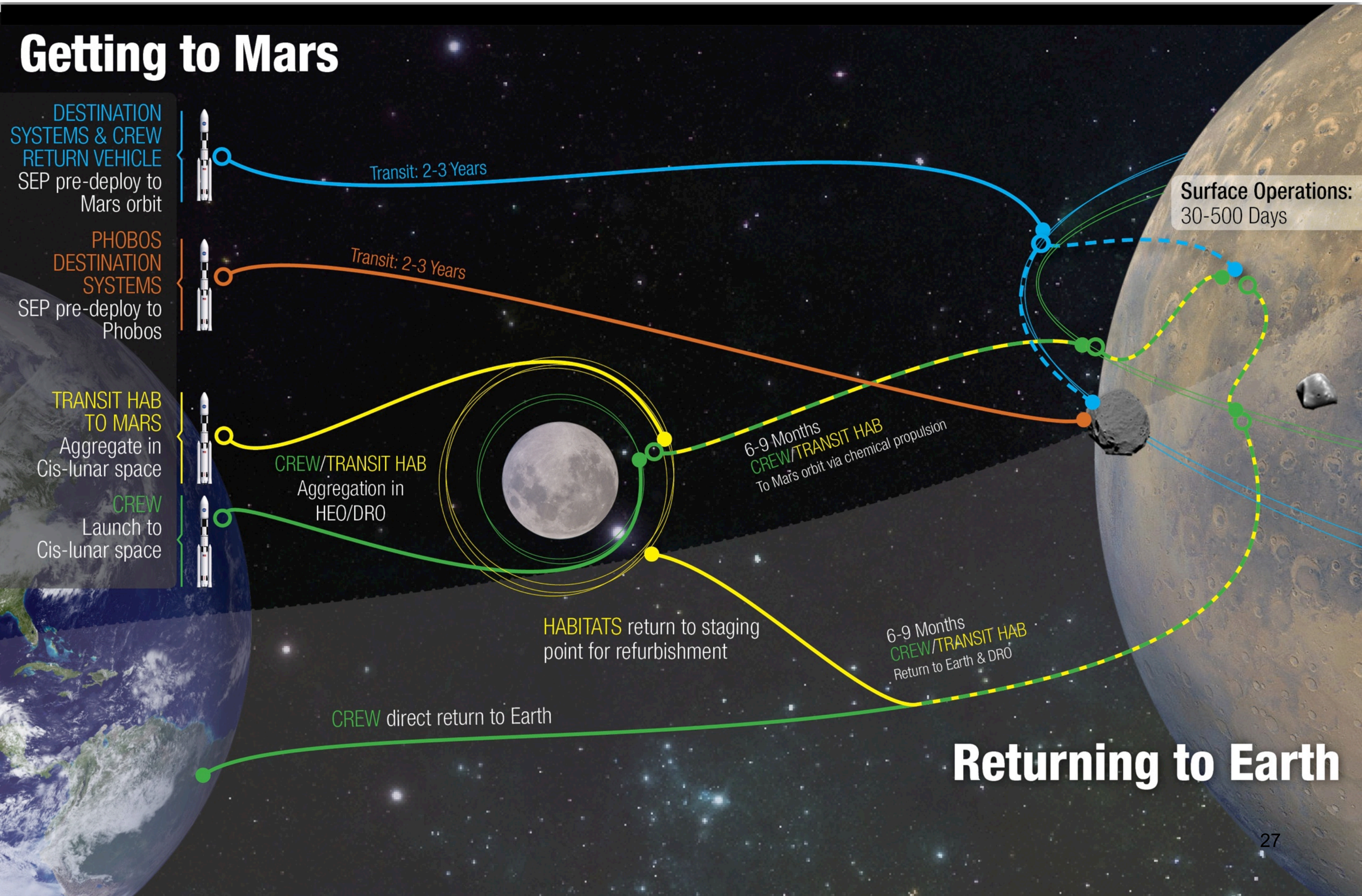
July 28, 2014

Greg Williams
DAA for Policy and Plans
Human Exploration and Operations Mission Directorate

Evolvable Mars Campaign – Capability & Mission Extensibility



1: Mars Split Mission Concept



Areas of Discussion

- HEOMD and SMD Cooperative Efforts, SLS Capabilities
- Program affordability/sustainability
- Finding for the council endorsing aspects of NASA's human exploration plans
- Recommendation for the council on SLS minimum flight rate
- Topics for future Meetings

Proposed NAC Recommendation July, 2014

TITLE: Minimum SLS Flight Rate

Recommendation: The NAC recommends that NASA conduct a trade study to determine a minimum launch rate for the SLS with respect to cost, safety, mission success, and performance.

MAJOR REASONS FOR PROPOSING THE RECOMMENDATION:

Current agency plans for SLS show a flight rate of one mission every other year, while preliminary mission planning for future exploration missions shows that a much higher launch rate may be necessary for mission success. The experience of many members of the council would suggest that the currently planned launch rate is less than optimal for maintenance of the supplier base, and the ability of the engineering, production, launch and operations teams to make appropriate risk decisions in a timely fashion.

CONSEQUENCES OF NO ACTION ON THE PROPOSED RECOMMENDATION:

Increased likelihood of future SLS program cancellation due to an inability to meet mission objectives for exploration.

Finding – Endorsement of Human Exploration Strategy

Proposed NASA Advisory Council Finding
NASA Human Exploration Strategy

Name of Committee:	Human Exploration and Operations Committee
Chair of Committee:	Mr. Ken Bowersox
Date of Public Deliberation:	April 14-15 2014 (HEO Advisory Committee)
Short Title of Finding:	NASA Human Exploration Strategy

The NAC endorses the following aspects of NASA's current approach to Human Exploration as presented by the HEOMD Deputy Associate Administrator at the July 30th, 2014 meeting of the Council:

Mars as a horizon goal for human space exploration
An intermediate exploration goal which is affordable, and allows development of systems which can later be used for more distant exploration of the solar system.
An approach that emphasizes affordability and allows re-use of system components.
A flexible approach, which allows reassessment of goals and objectives as the US economy and technical capability develop with time.
Potential areas of involvement for commercial and international partners.

www.nasa.gov